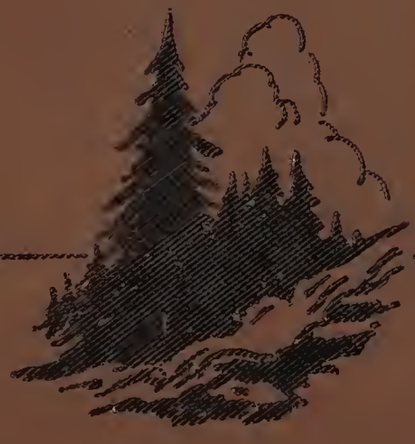
How the WORLD IS CHANGING

By EDITH HEAL



How the
WORLD *is* CHANGING

UNIFORM WITH THIS VOLUME

HOW THE WORLD BEGAN
The Story of the Beginning of Life on Earth

HOW THE WORLD GREW UP
The Story of Man

HOW THE WORLD IS RULED
The Story of Government

THE WORLD OF ANIMALS
The Story of Animals

THE GARDEN OF THE WORLD
The Story of Botany

THE WORLD'S MOODS
The Story of the Weather

THIS PHYSICAL WORLD
The Story of Physics

WHAT MAKES UP THE WORLD
The Story of Chemistry

OTHER WORLDS THAN OURS
The Story of Astronomy

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THOMAS S. ROCKWELL COMPANY
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CHICAGO

Publishers' Note

This book presents in popular form the present state of science. It has been reviewed by a specialist in this field of knowledge. An excerpt from his review follows:

> *"This book contains, in my opinion, a very clear and accurate statement of geological processes, and should prove very interesting reading to anybody who wishes to add one of the most important chapters of the earth sciences to his stock of natural philosophy."*

Signed: Adolf Carl Noé
Associate Professor
The Department of Geology
The University of Chicago

Squeezing the continents caused their borders to wrinkle up into the mountain chains

HOW THE WORLD IS CHANGING

By

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Drawings by

TERRY SMITH

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THIS CHANGING WORLD

THE world will continue to change as long as it endures. In this way it resembles our own span of life which is marked by growth and change from the beginning until the end. Like all growing things, the world shows the effects of its tremendous changes. In its features may be read the history of slow movements and churnings and the furious onslaught of the elements throughout past ages. It is like a sensitive body shaped by the touch of wind, of rain, of heat, of cold, and the weight of pressures that bear down upon it; torn and furrowed by the mysterious upheavals within its sphere—the rising of hot melted rock to the surface or the violent shifting and slipping of the layers of rocks beneath.

There is no permanence. The waves are never still; the sands move; the rain-washed soils are swept away. Eternal change follows endless turmoil and constant movements go in slow cycles or come like sudden accidents.

I

THE LANDS

MOST of the land is covered by *mantle rock*. Mantle rock received its name because it forms a mantle covering the solid underlying rock. Mantle rock is the part of this solid rock that has been exposed and has been broken up into loose material by rain, temperature changes, ice, wind, and chemicals in the air.

What covers the earth?

According to the changes and chemicals of the air, the amount of water and the effects of minerals that come in contact with mantle rock, it may change its form to clay, sand, earth, soil, gravel or loose rock.

Sometimes when the surface slope of the earth is steep, the loose mantle rock is washed away and the solid rock appears, as on the slopes of mountains or cliffs that face the sea.

The upper surface of mantle rock is called

soil and is usually from two or three inches to several feet deep. Soil contains certain minerals and food for plants. It must have air and water to support plant life. Soil is colored by mineral matter and appears as yellow, dull red, gray, brown or black according to the amount of iron it contains.

What is soil?

What is gravel?

The materials of the mantle rock have been sorted into different sized particles and classified. Names like gravel and sand and mud are given to the different materials after they have been graded. *Gravel* is the name for the particles that are larger than peas. A single piece of gravel is called a *pebble*.

What is a boulder?

Pieces of rock ranging in size from a small melon to large rocks often taller than men are called *boulders*.

What is sand?

Perhaps you have always thought of sand as a yellow material something like dirt usually found on a shore. The true definition of sand is a particle of mantle rock smaller than the size of a pea. Sand, also, has been named according to its size. It is smaller than gravel

Soil contains certain minerals and food for plants

but not as fine as dust. Most gravel is too heavy to be carried by the wind, but sand grains travel far distances. The sand changes into rounder and smoother grains the farther it travels.

What is dust?

The finest particles of all are called *dust*. Dust that is wet and massed together is called *mud*, *silt*, or *clay*.

Where do sand dunes come from?

Dunes are the mounds formed by wind-blown sand. When the wind blows sand it carries the fine grains close to the ground and any obstruction as a shrub, a tree, a stone, or a fence will check its velocity. The sand piles against the obstruction in drifts. More fine grains pile up until great heights are reached. The ordinary size of a dune is ten or twelve feet because usually the stronger upper winds begin to carry the sand away after this height is reached. But under certain conditions some dunes have reached as high as two or three hundred feet upward.

What shape are they?

Dunes are shaped according to the strength and direction of the wind as well as the amount of sand and the barrier which lodges the sand.

They may be ridges or hills, and often they occur in a series.

How do they travel?

As the wind blows constantly upon a dune, the sand is transferred from one side to the other and the dune is moved. Thus the same sand makes the new dune, and it is changed so slowly that its transformation is not noticed. But dunes are like the tortoise who runs his race slowly but surely. They have moved great distances in this slow steady way. They have invaded fertile lands in many instances and the people have had to plant trees and vegetation on their shifting slopes to help hold them down and to keep them from spoiling any more of the cultivated countryside. They have even been known to bury forests within the period of a man's lifetime.

What is a desert?

A desert is commonly thought of as a stretch of land that is practically useless to man because it is so dry. It is usually caused by insufficient rainfall. It may be in a zone of the world where there is little rain, or it may lie to the leeward of some mountain range which keeps

the rain off. About one-fifth of the lands of the world are deserts. We have come to think of deserts as all being like the famous Sahara where endless stretches of wind-tossed sand loom like a yellow sea, where sand storms blow with more fury and danger than snow blizzards, and sand hills rise like high mountains.

Desert plants also have sharp thorns and poisonous juices to protect them from devouring animals. The only thing that draws people to a desert is the underlying mineral deposit sometimes found in arid sections. On the whole deserts are destined to be the lonely places of the world.

What is a cold desert?

The plains bordering the Arctic Ocean and the *tundras* of Eurasia are cold deserts. They are barren lands which are covered with snow for about two-thirds of the year.

The cold desert, like the dry desert, is practically useless to man. Its frozen soil prevents agriculture and there is nothing except fishing and hunting to draw people to it. Reindeer in

the cold deserts play the same important role as camels do in the sand deserts.

Reindeer are the steeds of the cold deserts

What is an oasis?

An oasis, like a desert, is not usually what it is pictured to be in fiction. It is not a beautiful little garden in the midst of a sea of sand. It is more likely to be large enough to support a town and is often a small orchard of date trees rather than the two or three trees we have been led to expect. One African oasis contains a half-million date trees. An oasis is a piece of land in the midst of arid lands which is supplied in some way by water. It may be from a source outside the desert, from a river that starts in a well-watered region and runs through the arid

land, or it may be caused by springs or artesian wells. If part of the desert reaches an elevation high enough to draw moisture from the passing winds, this height may become fertile land in the midst of a country of barren soil.

What are wind-ripples?

The wind—like the waves—can make ripples on the sands. You have seen and felt the hard ripply surface of a sandy beach where it was shallow enough to touch your feet on the bottom. The surface of dry sand is often rippled in the same way by wind blowing over it. The ripples are usually very tiny—a fraction of an inch or so—and they resemble miniature sand dunes, constantly shifting in the direction that the wind is blowing, and making patterns on the sand.

How does sand carve rock?

Sand is the tool of the wind. It is easy for the wind to affect dust and sand, but when it blows against solid rock it is powerless. Only if it is armed with sand, can it make any impression on rock surface.

The principle involved is the same one used in the etching of glass which is accomplished

by a process of blowing sand blasts against the glass. The grains of sand make tiny dents in the glass. So it is with the wind-blown sand. Every grain that touches the rock surface wears it in some way. If the rock is of unequal hardness, the sand will dig out the soft portions so that it is almost impossible to believe that human hands have not been at work sculpturing the rock into its new clean-cut form.

Why is a pebble round?

Hard pebbles are smoothed into their round flat shape as if they were made of putty instead of hard stone. You have picked up smooth flat stones near the water or under the water and skipped them over the surface of the river or lake. You know that these stones have been water-worn, but perhaps have never realized just what that meant.

Running water carries the gravel on its bed along with it. As the moving stones scrape against the rock of the stream's bed, they are worn by the rubbing of rock against rock. The points and sharp angles are worn or rubbed first and gradually the stone is polished into a

smooth rounded shape which is usually called a pebble. Small pebbles may once have been good sized stones, and just as a lemon-drop finally disappears after it is sucked for a long time, so for a somewhat different reason, a pebble may be completely worn away and will sometimes disappear altogether.

How does a pebble tell where it has been?

A pebble tells where it has been by its shape and appearance. The round, smooth pebble we have mentioned is water-worn and so we know it has been at the bottom of some body of water or along a shore where the waves often covered it. A faint dimple or dent in the smoothness of the surface tells of some collision the pebble had on one of its long journeys. Perhaps it was washed against a jagged rock. A pebble that has traveled with a glacier is not as smooth as one that has traveled in the water. It is scratched and grooved from its rough journey over uneven ground and it has sharp angles caused by the jars and blows it has received. Pebbles that are buried in the sand are also angular rather than smooth, but they have no

deep scratches which characterize the pebbles that have been dragged over the ground by a glacier. The angular surface is caused by the sand drifting over the pebble and scraping against it. Pebbles buried in the soil often have fern-like patterns marked on them where decayed vegetation has touched their surface, or they may be covered with a shiny, dark skin which forms as a result of the contact with the iron oxide in the soil.

What made the mountains?

Far back at the beginning of the world there occurred the great slow movements of the earth, when the continents were squeezed upward by the sinking ocean basins. It was then that most of the mountain ranges were made. Squeezing the continents caused their borders to wrinkle up into mountain chains. Some of the ranges that were made by the crust of the earth crumpling into long, narrow folds are the Alps, the Southern Rocky Mountains and the Appalachians. The Alps may be thought of as wrinkled earth and if the wrinkles were spread out again it would be found that land measuring some

four hundred miles wide had been squeezed to a width of less than two hundred miles.

Another type of mountain—usually standing alone rather than in a range, is the volcanic mountain. This peak is cone-shaped and often very high. It is made of volcanic ash and masses of rock hurled forth during an eruption. If the volcano erupts frequently, the pile of ash and rock grows bigger as time goes on. Fujiyama, the Sacred Mountain of Japan, Mount Shasta and Mount Rainier are volcanic mountains whose cones have reached huge dimensions.

Other mountain ranges are caused by lava beneath the earth which rises toward the surface in certain localities, uplifting the rock beds into great mounds, sometimes as high as three thousand feet above their surroundings.

How are mountain peaks formed?

Mountains have not always been peaked. The sharp needle-like crags have been carved by weather, one of the many sculptors shaping the features of the earth.

Rock is a poor conductor of heat so when it is exposed to a dry, sunny atmosphere it becomes

very hot on the surface and expands. But the inner portion of rock remains cool. Breaking and cracking results. In mountain regions, especially, the topmost parts of the mountains are usually found to be crumbling masses, and when there are sharp degrees of temperature changes, the loud report of the breaking rocks is often heard. In places where it is very hot during the day and cool at night, masses of rock weighing as much as two hundred pounds have been split off. Water will break the rock also. The rain fills the pores and cracks in the rock. When water freezes, it expands and if the pores of the rock are not large enough to hold the ice, the rock splits open. This constant shaving down and crumbling of the bare and most exposed parts of the mountains has caused the forming of crags and peaks.

What is a hill or a butte?

Sometimes one section of land is made of harder rock than the lands surrounding it. Effects of the rain and the weather and sometimes a passing stream will wear down the softer rocks of the countryside near and leave the hard

rock elevated. If this hard rock is a small section of land it becomes a butte or a hill. If it is a larger section, it becomes a plateau. Most plateau ranges of any great size, however, were caused by a movement of the earth similar to the continent-forming movements. Scientists have not been able to learn much about plateaus but have agreed that they were probably an immense lifting of the lands caused by some vertical force, even more spectacular and greater than mountain forming itself.

Why do shorelines change?

As well as the great slow movements of the continents and the seas, constant smaller movements are going on. Their effect upon the earth's surface is like the warping of wood. They cause slow swellings upward of the land —or slow bulgings downward. The sinking of a sea border may cause the water to come up and cover land that has formerly been above sea-level. Uplifted land or a downward movement of the sea may cause the stonework that guarded the shoreline in past centuries to stand high and dry above the water today. The warp-

ing of the lands is slow and often very slight—from a few feet to a few fathoms a century is a spectacular change. Most movements affect the land by inches.

A quicker force than the earth movements is the constant beating of the surf against the shore. Here is a changing of shore-lines that can be seen within the limits of a lifetime. The waves and the currents are cutting, smoothing, shaping the ever-changing beaches continuously. Water is a skillful sculptor.

"Waves walk always to a shore"—the coast is never free from the dashing of high waves or the gentle lapping of the calm undulating swells. Off-shore islands are washed away. Wave-cut cliffs border the sea. Bays are deepened. Harbors are filled in. The sands withdraw as the relentless waters push and batter. Thus shorelines change and a new rim of the sea is formed.

How are sea-caves made?

Waves beating against the base of a cliff slowly excavate caves. The wave usually washes at an angle slanting upward toward the

surface of the land. If the cliff is low, the water often forms an opening in the roof of the cave and shoots forth in a sparkling, far-flung spray.

Water slowly excavates caves. If the cliff is low, the water often forms an opening in the roof

What is a sea-cliff?

As the water digs into the shore, it gradually undermines it and the unsupported part falls. A steep cliff is left at the water-line.

How are capes and off-shore islands formed?

Vast ice sheets called glaciers move over parts of the earth. They carry along boulders and earth and when they have melted they leave great piles of this rock in various places. Some of it is left off-shore and islands are formed. Later, certain of the islands may be connected with the land by sand-bars and jutting capes

and small peninsulas are formed. Peninsulas are also formed by the slow wearing away of the coast in one part so that extended arms of land are left reaching out into the sea.

How are great islands formed?

Many large islands like Great Britain are thought to be parts of drowned continents that have remained above the level of the sea. Other islands in the sea are the tops of volcanic cones, for there are volcanoes under the sea as well as on the land.

What is a valley?

As rain falls on the uneven surface of the earth, it disappears in different ways. Part of it sinks and forms ground-water, part of it evaporates, and some of it runs off the surface, finding its way to the sea. Of the water that runs off the surface, a greater volume flows through the slight hollows than over the level ground. As more water flows, the stream in the hollow becomes faster and more forceful and it digs the hollow deeper. The deepened gully is called a ravine. But the process does not stop. The streams continue to flow faster and to cut the land deeper until the hollow becomes large

enough to be called a valley. A valley is the result of many showers running off a depression in the land surface and deepening that depression into a permanent hollow.

Why is a valley crooked?

The course of a valley that has grown out of a gully is rarely straight because the slope above the gully is usually uneven and more water comes in from one direction than another. As there is more wear on the side with the most water, the gully will be turned in that direction. It will continue in this direction until some unevenness of the land surface allows more water to come into it from some other direction. Then it will change its course accordingly.

What is a tributary valley?

Besides the main valley caused by the water that runs toward the sea, other small valleys branch out like limbs from a tree trunk. Wherever the slopes of the gully are marked by a slight hollow, water may start running into it and another gully is formed. This gully is deepened into a ravine and later into a valley.

The uplifting of two mountain folds may leave a deep hollow between. Water may help

to deepen the valley, but this type of valley did not develop because of water as a gully does.

In what other way can a valley be made?

An overflowing lake whose water brims over at the lowest point in its basin forms a stream that flows toward the sea. This stream leading out from the lake may drain the lake unless surplus water is added continually, and a valley is formed when the water has left the stream.

An old valley has gentle slopes because as it gets older the water begins to wear down its sides

How does a valley change as it grows old?

When a valley is young, it is narrow and its slopes are steep. But as it gets older the water begins to wear down its sides and the slopes become gentler and lower so that the valley widens. An old valley is wide and flat and its

tributaries, like it, are broad gentle depressions rather than steep hollows.

How can a valley keep from turning into a river?

As long as the valley is supplied with water from showers alone, it remains a valley without possessing a permanent stream. When the rain stops falling, the water in the hollow soon dries up and the river that has started to flow disappears. But as soon as the valley is supplied with water from other sources than the showers, water stays in the hollow and a river is formed. The bottom of the valley becomes a river bed.

What are gorges and canyons?

A deep and narrow valley is often called a gorge if it is small and a canyon if it is large. Swift streams with force enough to deepen the valley are the main reasons why canyons are formed combined with high land slopes made of a rocky substance that will not wear away. The greatest canyon known is the Grand Canyon of the Colorado. It is a mile deep and eight to ten miles wide at the top. It is still a young valley for its base is very narrow which shows that the streams that wash through it have still a great deal of cutting down to perform.

What are caverns?

The rain that stays beneath the earth is called ground water. This ground water dissolves parts of the rock and makes it porous. In certain cases where the rock is made of a material like limestone which can be dissolved, instead of dissolving parts of the rock, whole sections are washed away and caverns are made. Caverns are usually composed of many smaller chambers or caves joined by strips of rock. Sometimes the roof of the cavern "caves in" and there are amazing examples of natural bridges that have been formed when a single strip of rock remained after the rest of the cavern roof had fallen.

What is a volcano?

The intense heat within the earth has reduced some of the rock to liquid. From time to time this molten rock rises to the surface. Part of it stays beneath the earth's crust, but some of it rises swiftly and with great violence to the surface where it hurls itself into the air. When lava bursts through the crust of the earth, a volcano is formed. The hot lava, ash, cinders and other materials which are exploded into the

air fall to earth and often form a cone-shaped mountain. This mountain usually has an opening at the top called a crater. Hot rock and gas in small quantities pour continuously from the crater and from time to time another large eruption may occur where lava in great quantities is expelled from within the earth. There are about three hundred and fifty active volcanoes in the world today. What causes lava to burst from the earth in some places and not in others has never been agreed upon—some geologists think that volcanoes bear some relationship to the seas and others believe that they are found in places where the earth's crust has undergone changes of various sorts.

Eruptions of any size bring a great deal of danger. The great quantities of steam that rise are condensed into water and floods may accompany the terrible accident to the earth. The gases that issue from the volcano are often poisonous or so hot that they destroy life. Great pieces of solidified lava are hurled forth.

The most famous disaster caused by a vol-

cano was the burying of the city of Pompeii in 79 A.D., when the volcano Vesuvius erupted and rained down its cinders and ashes, covering the city and all its inhabitants.

What causes an earthquake?

There are constant movements going on beneath the surface of the earth. Sometimes a portion of the underlying rocks may slip or shift their position and a tremor of the earth results. If this is violent enough to be noticed on the surface of the earth, it is recognized as an earthquake. There are undoubtedly tremors of the earth that we never feel occurring from time to time.

Where is an earthquake likely to occur?

Like other of the earth's mysteries, there can be no set rules about earthquakes. But geologists have agreed that certain regions which are the scene of changes and movements of the earth are more susceptible to earthquakes than others. These regions may be near young mountains, near the mouths of great rivers where sediment is gathering, and land is being formed, or in the vicinity of volcanoes where temperature is subject to rapid changes.

Earthquakes are less disastrous than they may at first seem. Only a few are violent enough actually to destroy large numbers of people and property. And their effect on the world itself is slight. The slumping or shifting of a rock beneath the surface is no more than a slight movement beneath a coverlet. The surface is temporarily disarranged but no permanent mark has scarred it.

What are some of the effects of earthquakes?

An earthquake may fracture surface rock, or what is more likely, may open up a crevice that was already there but had never been separated far enough to make a gap.

Sometimes a basin-like opening is formed during an earthquake, and this is believed to be a collapsed cavern of some sort.

Ground water is sometimes affected, so that springs cease to flow after an earthquake. This may mean that the earthquake blockaded its water supply. The greatest danger is when standing water is stirred. Great sea-waves may arise, sometimes as high as sixty feet, travelling rapidly like walls of water for great distances.

These waves sweep over the lands and cause loss of life and the submerging of houses and lands.

Coasts often rise or fall during an earthquake and the sea-bottom itself may be disturbed so that telegraph cables are broken.

What causes a landslide?

An earthquake is one means of causing a landslide. The shaking of the earth may dislodge masses of rock from cliffs, sending them downward.

But the ordinary cause of a landslide is the work of the ground-water that seeps through the soil. When the soil becomes full of water it begins to slip or slump. If the land happens to be on a steep slope, it slides swiftly and in large masses.

A third way in which land falls is when the sea waters or rivers have worn away the shoreline of a cliff and the top of the cliff falls because it has no support beneath it.

Can land be struck by lightning?

There have been rocks struck by lightning as well as trees and houses. The rocks were fractured and sometimes moved considerable distances away.

There are evidences of sand having been melted together for a short distance when lightning struck it, producing a partially fused material hardened into a glassy substance. But such a thing is so slight it passes unnoticed in a world of greater changes.

How is land lost?

Land is being constantly lost—devoured by the waters, drowned beneath them, blown away by the winds and destroyed by every conceivable force of nature.

One of the most amazing losses of the land is one which is never seen and probably rarely thought about.

The dust in the air often forms mantles a hundred feet or more in thickness covering large areas of the earth. If all the dust transported by the winds fell on the lands, a good part of the land that is lost would be regained. But three-fourths of the earth's surface is covered with water and three-fourths of the dust that settles falls into the rivers and lakes and seas and is lost forever.

Chapter II

THE WATERS

Where did the oceans come from?

LONG, long ago, when the earth came to rest —a battered, wind-blown piece of the sun hardened into a great sphere, it hung in space gathering in the star-dust—the planet dust—the air—and finally the moisture that was in the atmosphere about it. The moisture came down as rain.

The surface of the earth was an uneven stretch of highlands and lowlands. The rain filled the hollows of the lowlands and the oceans were made.

It seems as if something as tremendous as an ocean must have been formed in a way more complicated and mysterious than the mere spilling of water in a great dish of land, but that is all that happened.

The bottom of the ocean has heights as well

as depths that would be called plateaus and valleys if they were on the surface of the land. But the broad ranges of highlands are so smooth as to seem almost a high plain instead of being shaped into hills and peaks as the highlands above the earth are. The reason is obvious. Beneath the water, the surface is protected from the carving of the weather forces.

What does the ocean bottom look like?

There are volcanoes on the bottom of the ocean—some of which rise so high that their tops appear above the surface of the water and form islands.

What corresponds to mantle rock under the seas?

At the bottom of any body of water, deep or shallow, there are certain deposits of sediment. The different materials that make up these deposits are interesting to discover. Many of them have traveled great distances.

Near the shores the deposits are mostly sand and gravel and mud washed from the lands. This same type of material persists as far out as the 100 fathom mark. But beyond that, in the deep sea beds, more varied deposits form. Here are found various matters of organic or chemical

origin called *oozes* as well as the colored muds.

What are the colored muds?

It sounds like a fairy story to say that blue, red and green mud are found at the bottom of the sea. To explain how these muds became colored it is necessary to understand chemistry, but, to say it simply, their color is dependent upon the changes they have passed through since they were deposited beneath the waters.

What are the oozes?

The oozes are largely made up of shells and skeletons of creatures of the sea that live near the surface and fragments of sea plants. When these marine animals die, they sink to the bottom with their shells and form a part of the deposit there.

What accidental deposits have been found?

Sometimes in the deep sea beds land materials are found that must have been brought there by some strange chance. Boulders have been discovered. One explanation is that they were caught in the roots of floating trees and so carried far out beyond the shallow deposit region where they belong. Another explanation is that giant icebergs, carrying rocks and other land materials embedded in their frozen

bodies, floated seaward where they gradually melted and released their strange cargoes.

Volcanic glass and ash have also been found and certain magnetic grains which are thought to be part of fallen meteors.

A strange, dim, green world of plants with extraordinary fish swimming about

What are the measurements of the oceans?

The oceans cover three-fourths of the surface of the earth. If the earth did not have highlands, it would be completely covered by water, measuring about two miles deep everywhere on its surface.

The surface of all the oceans has been estimated to be about 143,259,300 square miles.

The deepest point thus far known in the oceans is 31,614 feet below the surface of the Pacific at a spot near the Ladrone Islands. This is an exceptional depth and is what is meant when people refer to the "deeps" of the sea. The greatest average depth ranges from 12,000 to 18,000 feet, though a large area is as shallow as 6,000 feet.

What makes the ocean salty?

Rivers are constantly emptying their waters into the sea. With this inflow comes quantities of mineral deposits. More than three-fourths of the dissolved mineral matter in the ocean waters is common salt.

There are other important deposits as well. Calcium carbonate is one of them, but it is constantly used by sea creatures to make their shells so it is used up nearly as fast as it comes. There is little use for salt, however, and that is one of the reasons there is so much salt in the seas—it has stayed there, adding to its quantity for millions of years.

In the slow movements of the earth we have seen that there are warpings of its surface so that the borders of land and sea are sometimes lowered. Downward movements of the land have often been the cause of great shallow seas, where the ocean has flooded the lowered continent over a great area. Such a submerged continent is called an *epicontinental* sea. The North Sea in Europe is an example of a shallow sea and Hudson Bay in North America is another.

What is a shallow sea?

The pictures we have seen of a strange dim green world of plants with extraordinary fish swimming about in it are all portrayals of shallow waters. The ocean deeps have no life except near the surface of the water. But the fantastic scenery of under-sea countries does exist, where sea-weed grows to lengths that would stretch out taller than the tallest trees and is often six inches in diameter. Many sea plants float, giving them an eerie effect of being alive. Contrarily, the animal life is often fixed and barnacles and polyps may live their entire

What is the life of the ocean world like?

lives on the sea bottoms half buried in the soft mud.

The temperature of the water affects life in the water much as it does on the land. Just as certain animals are found only in cold climates on earth, so seals are only found in cold waters. Just as tropical creatures flourish only in the warm climates, so coral reefs are made in warm waters by the polyps who like water that is shallow, clear and warm.

The greater the depth of the ocean, the colder it is. The average temperature of the ocean is probably about 39 degrees F., but in shallow waters it may be as high as 60 degrees F., and the deeps may be as low as 35 degrees F.

What influences affect the oceans?

Just as the countenance of the land is changed by rainfall and temperature, by wind, by ice, and by the internal movements of the earth, so the ocean is affected by outside conditions.

When the wind blows over the seas it creates waves. The waters may rise as high as forty feet in a storm. If the air is still, the water may become glassy and very calm. The calm may

be as terrifying to seamen as the storm. Much has been written of the voyages that men have taken since the far off days when the wind was necessary to sailing vessels.

Larger movements than waves are constant circulators of the waters which are called ocean currents. Ocean currents are started chiefly by the winds and directed by them as well as by the position of lands, the rotation of the earth and the depth of the waters.

The Gulf Stream is one of the most famous of the ocean currents. Often, coming out of stormy, wintry seas into the Gulf Stream, the voyager will be able to go without his coat on deck for two or three days. When the Gulf Stream is left behind, he must put on his woolens and shiver beneath his steamer rug again.

The sun and the moon attract the earth somewhat as a magnet attracts steel. They pull the earth toward them slightly and the waters are disturbed and the movements that result are called *tides.*

Earthquakes and the eruption of volcanoes may affect the bottom of the sea much in the same way that land surface is disturbed. Proof of this is shown by the volcanic ash and cinders found on the sea bottom and by the breaking of telegraph cables when an earthquake lowers the sea bottom or obstructs it by an upheaval.

How is a bay formed?

When the sea rises and covers the surface of the land, new coast-lines are made. The water follows the contours of the land, and naturally more water flows into the hollows of the land than over the level surfaces. Often the lower parts of valleys are filled with water and bays are formed. There are other ways of forming bays. Small inlets may be made by the water wearing away the land. Coast-lines change and the waters invade the level areas between the uplifted lands. The majority of bays, however, may be thought of as drowned valleys caused by the flooding of the waters.

How are lakes made?

A lake resembles a miniature ocean. It, too, fills a basin of earth. Many lake basins were dug by glacier movements either in bed-rock

Old Faithful in Yellowstone Park erupts regularly every hour or so

or in the drift that the ice sheet carried with it. Other lakes are made by rivers. When a river floods over, its banks are built up by deposits of earth and sometimes dams are formed. The flood on the other side of the dam becomes a pond, which in time may turn into a lake.

What are salt lakes?

There are a few lakes in the world that are salty like the ocean. Certain of the salt lakes were probably parts of the ocean at one time and through some change of the earth's surface became separated from the seas by land. Other salt lakes were once fresh water lakes. They are situated in a dry climate. If it is dry enough so that the water in the lake evaporates faster than fresh water is added, the salt that the fresh waters bring in does not evaporate and becomes more noticeable because there is less water in the lake to dilute it.

What is a marsh?

When a lake is drying up, it is called a marsh. When a marsh dries up, the lake becomes extinct.

What is ground water?

The rain that sinks beneath the surface of the earth and stays there is called ground water.

The soil is loose and absorbs the water easily so that it seeps through to the rock beneath where it sometimes sinks into cracks that are very deep in the earth.

What happens to ground water?

Some ground water evaporates, some is sucked up by plants, some forms wells or springs, and some returns to large bodies of water like rivers and lakes.

What is a geyser?

A geyser is a hot spring which erupts at intervals as a volcano does. There is some mysterious connection between geysers and volcanoes which has never been fully explained. This is known because geysers are found only in volcanic regions. It is believed that the water of a geyser is heated by lava under the earth.

Some geysers erupt at periods of years apart, and others, like old Faithful, spout their waters every hour or so.

What is a river?

When valleys are made and are watered only by rain they remain valleys, but if sufficient ground water feeds them or water from some other source is given them, a permanent stream

is formed in the valley bed, which is called a river.

An old stream is one which moves along sluggishly and instead of cutting its channel deeper, widens it and floods over the banks.

How are waterfalls formed?

A waterfall can be made in a river where the bed is composed of soft and hard rock. The

The water falls over the high rocks

soft rock is cut lower by the water and the hard rock remains high. The water falls over the high rock.

If the course of a river is directed toward a cliff, the stream continues to flow, dropping over the cliff in a waterfall.

What is a delta?

When a stream flows into a larger body of water as a sea or a lake, its current is stopped. It ceases to be a stream and merges with the greater body of water. It drops its load of earth and bed-rock materials that it has washed along with it at the place where it enters the larger body of water to become a part of it. If the material that it drops is not later removed by the waves a delta is formed. A delta is usually shaped like a fan and like the Greek letter Δ which is called delta and gave the river deposits their name.

What accidents may happen to rivers?

Besides having their water stolen by other streams, rivers may have their flow endangered in other ways. If the lower end of a valley sinks below sea-level, the sea floods the valley and forms a bay, thus drowning the river that was formerly there.

What is a snow field?

In certain parts of the world, usually mountainous sections or the arctic regions, where a low temperature exists all year long, snow never melts entirely away. It lies in great stretches of white waste. It does not remain pure snow,

however, for long. The light flakes become coarser and harder until layers of ice are formed. The ice piles up—season after season. Sometimes a layer of earth comes between the ice of one year's winter and that of the next.

After a while the great ice field begins to move slowly. When it begins to move, it is no longer a snow field. It has become a glacier.

What is a glacier like?

A glacier may range from a fraction of a mile to many miles in length. They are usually longer than they are wide and hundreds of feet thick. In the Alps they often range from five to ten miles in length. Glaciers, like sand dunes, move too slowly to be seen by the human eye. They are measured by various tests and have been found as a rule to move three or four inches a day. Certain glaciers in Greenland and Alaska move much more rapidly—the Muir glacier in Alaska moves seven feet a day and some of the Greenland glaciers as much as 50 or 60 feet a day. The record is 100 feet in a single day.

A crevasse is a break or fracture in the mov-

What is a crevasse?

ing ice sheet, often very deep and wide. A glacier sometimes cracks if the ground it moves over reaches a higher level.

How does a glacier affect the land surface?

A glacier moves over the land like a giant plough, uprooting rocks and earth and even trees in its path. When it moves through valleys it often widens the bottom of them and smooths their slopes so that the valley that was V-shaped before becomes U-shaped after a glacier has gone through it.

As a glacier usually melts before it reaches the sea, it drops its load on the lands more often than in the waters. Valleys may be filled with glacial deposits and certain soils are glacial drifts. If the glacier should reach the sea, islands may be made off-shore by the dumping of land materials onto a relatively shallow bottom, and the glaciers become another means of wearing away the continents.

What is an iceberg?

When glaciers reach the sea, certain parts of them break up and float away and these masses are called icebergs. They float like mysterious boats over the waters, sometimes carrying

Icebergs float like mysterious boats over the water

strange cargoes of boulders and earth far distances from the lands.

What were the ancient glaciers like?

In the days when the world was filled with fantastic forms of giant creatures and when man had not yet made his appearance or was just coming into existence, the climates of the earth passed through great changes and temperatures were reduced. Great sheets of ice moved slowly over large areas of the lands, blotting out life. Then the climates grew warmer and the ice melted. Life began to grow once more in the areas once ice-covered. Again the glaciers were formed. The animals fled southward or were killed. Indeed it is believed that the great ice age was the cause of many types of strange mammoth creatures vanishing, never to return.

Ice plays a dramatic part in the history of life, whether it is this ancient ice that destroyed life so mysteriously, or whether it imperils life in our own time. The Titanic struck an iceberg and what was thought to be an unsinkable ship was lost. Every year there are stories of Alpine

climbers who have fallen into a crevasse. Often years later, as the glacier moves its slow and steady course, the frozen body of some lost climber is brought down into a valley, and the crevasse gives up its victim.

What is the importance of water?

Water takes various forms as it appears on the surface of the earth. In each form, it is of infinite value to humanity and to the lands. It is a means of transportation. It irrigates the soil. Its power creates electricity for man. When it contains minerals it is health-giving —and in any form that is pure, it is necessary to our existence.

There is ever something awe-inspiring and dramatic about it. It carries danger in its wake. Flood and shipwreck and tidal wave have all played their part in the exciting fiction of its history. Men of the sea must be stern of heart.

But it is invaluable. Its dangers are probably less than those on the lands but because a tragedy at sea stands out alone and isolated it looms before us.

Chapter III

THE INSIDE OF THE EARTH

JUST as we cut an orange in half and find sections, and an apple in half and find a core, so if we could cut the earth in half we would find that the world we live on seems to be made up of layers. These layers are of many different kinds and colors and substances. They are like the layers of Black Ball candy that you bought when you were small. The outer layer was black—when you licked that off the ball became pink. When the pink layer melted, the ball was white and finally in the very center hidden beneath all the layers was a hard little caraway seed. The earth has an outside rim that we can see with our own eyes. It is called mantle rock. This layer measures from a few feet to several hundred feet deep and is made of earth and broken rock. Next appears a great

What would the earth look like if it were cut in half?

zone of solid rock composed of many different layers, built in sections like the floors of an apartment building and extending some fifty miles downward. And finally—at the very center of the earth about 4,000 miles beneath us is a core that is probably of a metallic substance. This has never been seen, so we can only imagine it and believe it is there because the scientists have reached that conclusion after years of study and experiment.

Is the inside of the earth hot?

We know that the temperature of the interior of the earth must be very hot. When the waters of a geyser shoot into the air, they are boiling and steaming, and if a volcano erupts, the lava is a hot stream of melted rock. One cause of this heat is probably the intense pressure of the layers of rock, one on top of another. The heat that arises is kept alive because the outer layers of rock are like a blanket protecting the hot center from the cool atmosphere without. One scientist believes that the temperature at the center of the earth is about 36,000 degrees F., but there are contradictory opinions.

The rocks of the earth are divided into two great classes, according to the way in which they were formed. A third classification is given to a rock that combines the characteristics of the first two. One type is called *crystalline* or *igneous* rock. It is formed by the hardening of a hot liquid substance inside the earth from pressure under conditions of high temperature. It is really hardened lava in its rock state. The second class includes all the *sedimentary* rock and is called *stratified* rock. These rocks are formed by deposits, blown by the wind or carried by moving glaciers or running streams. Often sedimentary rocks are made of the broken and crumbled crystalline rocks that have been cemented together with other materials of the earth and hardened. *Stratified* rock occurs in layers, usually relatively thin because they are soon covered up with a new layer of sediment. The older a layer of rock is, the deeper down it lies, for it has had many years to be covered up by new layers. *Metamorphic* rocks are formed from both igneous and sedimentary

What are the principal classifications of rocks?

rocks, if the original deposit has been greatly changed by subsequent pressure, heat or chemical agencies.

What are the four great series of sedimentary rocks?

Beneath the earth, then, are layers of rock. These layers are called *strata.* The four greatest series of sedimentary rocks were probably once beds of the oceans. They represent four great periods in the history of the earth. From the fossils embedded in them, men can tell what kinds of animals lived in each period and they can picture fairly accurately what the world was like then. The oldest layer of the four is called the *Proterozoic.* It means earlier life. It contains very few fossil records because life at that very ancient period was too tiny to leave any impression or to be preserved. The next layer is called *Paleozoic* which means ancient life. Many records are already found in this strata. In the *Mesozoic,* a period of middle life, the sedimentary rocks contain still more fossils, and the *Cenozoic,* a strata of recent life, is a fairly complete chapter of knowledge and history of organic life. The shell of the earth has

other layers of rock, but these four series are principally sedimentary in origin and are of the most importance because only sedimentary rocks contain fossils, or metamorphic rocks formed from sedimentary.

Why are there no fossils in igneous rocks?

Igneous rocks are formed from a hot liquid rock which either hardens before it reaches the crust of the earth or as soon as it has reached it. Therefore fossils are never found embedded in them. Fossils are the remains of living plants or animals. They are caused by the preservation in rock of dead creatures or vegetation. To be preserved, the relics must be covered over with layers of sediment and protected from decay. Igneous rock hardens before any relic has a chance to be preserved or hardens beneath the surface of the earth where animal life does not exist.

The oldest rocks on earth are of igneous formation and form a foundation series called the *Archean* era. They are known to be very old because they lie beneath the sedimentary rocks.

What is decayed rock?

The outside crust of the earth is made of decayed rock. The hardest rock will decay if it is exposed to the harsh conditions of the weather. It may take years of wearing down to finally reduce the rocky substance to soil but if it is exposed to the force of air and water it is almost certain to lose its original form. This outside layer of decayed rock later becomes one of the inside layers of rock, after it has been covered up and has hardened into a new rock formation. Water is the greatest enemy of rock. It penetrates into the cracks and openings of the rock and when it freezes, it expands and splits open the boulder. Trees and growing plants are another enemy. Beneath the surface of the earth their roots push out in all directions. If the roots touch a rocky surface, the force of the pressure is often enough to break the rock and start it crumbling on its way to decay.

What causes the coloring in rocks?

The color in rocks is due to the presence of minerals. Iron is one of the most ordinary minerals found in both igneous and sedimentary rock. Iron will color a rock dark green,

dark brown or black. In sedimentary rocks all red-brown colors are caused by iron but grays and blacks are usually the result of the presence of carbon. The lovely amethyst shade found in certain crystalline rock is due to a small amount of maganese oxide in the quartz. The green of other semi-precious jewels is probably a color created by chromic oxide.

Sedimentary rocks usually follow a certain color chart. The shadings of the red-brown tones caused by the presence of iron range from pink, red, dark red, to red brown. Another range of yellow brown tones indicates that limonite is in the rock and the rock is colored pale yellow, buff, or yellow brown. The range of whitish grays to black indicate carbon is present to the degree it has discolored the rock.

The Dolomites, a mountain region of the southern Alps, contain some of the most startling streaks of color in the various peaks imaginable. They are named after the sedimentary rock called dolomite which is formed from pure limestone partially mixed with magnesium.

How are crystalline rocks formed?

Deep down near the center of the earth is a layer of rock that is so hot it is in a liquid state. If the pressure of the earth bears down upon this liquid, it hardens and becomes a part of the metal core of the earth. But if for some reason it fails to harden, it often pushes its way toward the earth's surface. Sometimes it bursts forth and a volcano is formed, but often it nears the crust of the earth and is stopped in some way. There it usually cools and gradually hardens.

When this liquid or molten mass of rock cools slowly and becomes solid, the minerals in it form crystals. Crystals are particles in the rock that always have the same part to play in the making of rock of this kind. They are the mineral materials of the rock that have become separate bodies under the power of changing temperature. If the hot rock cools slowly, the crystals are large. It it cools quickly, the crystals are so small they cannot be seen and are sometimes not formed at all. Rock formed so quickly that the mineral material did not have time to turn into crystals is *glass*.

This question sounds like a riddle with a trick answer, but its answer is true and scientific and is found in the story of crystalline

Why is a granite building like a precious jewel?

Crystals formed from the minerals in crystalline rock

rocks. The granite that is used for so many fine buildings in the world is a liquid rock

which cooled and grew solid very, very slowly. The crystals in granite are large and firmly welded together so that the rock is very strong. Granite, then, was made by a stream of liquid rock gushing forth from the hot centers of the earth and cooling into a solid mass before it reached the surface of the earth. Perhaps the block of granite was never discovered until many layers of rock covering it, had worn away.

Precious stones are nearly always some form of the crystals that have formed from the minerals in crystalline rock. When you see shining, sparkling particles in a piece of granite, you may know that they are some distant relative of valuable precious stones.

Why are some crystals more precious than others?

The crystals in rock are formed under different conditions—some are made slowly, others quickly. Some have different combinations of mineral materials than others. Some are harder in substance. All these things go into the history of the creation of precious jewels.

The stones that are purest, not marred by cracks or clouded by other materials, colored

most beautifully, hardest, and most sparkling become the most valuable.

Stones like diamonds, rubies, sapphires, and emeralds are more valuable than the amethyst, rock crystal, or topaz because they possess qualities of hardness, brilliancy, and color that are uncommon and are only found in certain places in the world.

What colors precious stones?

Jewels are colored in two different ways. They may contain a colored substance and take on that color as the amethyst does. This is the same principle as the waters of the sea being colored by coral beds. Or they may be colorless and reflect rays of light on their irregular surface in miniature rainbows as a diamond or an opal does.

What is the romance of a gem?

For hundreds of years, the imagination of man has been captured by the beauty and value of precious gems. Primitive people have had superstitions about them. Jewels were supposed to be able to cure diseases. They were used for charms. They were lucky or unlucky. To this day plays are written of the disaster that fol-

lows the Cat's Eye, and birthday stones are a common tradition.

Not only in mystery and adventure stories but in history itself, precious gems have had their own careers, borne names that are recognized years after their discovery, and lived lives as dramatic as those of human beings. There is the mysterious tale of the "Great Mogul," once owned by Emperors of Hindustan, which ends in the vanishing of the jewel. Where was it lost? Where is it hidden? The two largest diamonds in the world are the "Excelsior" and the "Cullinan." What will be their story—will they too disappear some day? The Cullinan, found in 1905, weighed when it was found about one and a half pounds and measured four and a half by two and a quarter inches. It was cut into nine large stones, two of which are the largest cut diamonds in the world, and about a hundred smaller ones. It belongs to the British Crown.

The romance of the creation of jewels is a fascinating tale. The crystals in diamonds are

made principally of a substance called *carbon*. By some curious twist of fate, ordinary coal—made from a different process entirely—has for its principal material this same carbon. This coincidence is like two brothers who are equipped with the same ancestry, but brought up in two different places under different conditions, they become two different types of men. Perhaps one is a poet, and the other is a plumber. Thus the diamond, prince of the materials of the earth, is closely related to a lump of coal.

How were the stratified rocks made?

Stratified rocks are formed when all kinds of loose materials on the surface of the earth—clay, sands, gravels, volcanic ashes or cinders, become hardened by pressure or cemented by water and hardened when the water dried out.

A material like sand is formed from particles of crumbled granite, worn by weather and other forces of nature into a powdery form. Gradually the loose bed of sand becomes sandstone, as soft deposits of fragments of shells may become limestone and hardened clay may turn into slabs of slate or shale.

What is an adobe house?

In the arid regions of western North America, especially in the regions of the southwest near the Mexican lands, houses are often built of a fine-grained material called *adobe*. This is a sun-baked clay made into bricks. It has the characteristic rock colorings: yellowish, yellow-brown, gray-brown, or chocolate brown.

The origin of this yellowish dust is the rock of the mountains and higher slopes of the hills in neighboring regions. Here the decayed rock lies in crumbling surface soil. It is carried down to the lower plains by rain wash and the wind. The surface of the earth is constantly moving downward. Gravity is one of the causes of this downward movement. All things fall down. The earth that rests on a hill top has a natural tendency, then, to fall down too. Water runs down also. The water seeking a lower level carries with it the light rock dust. Down in the valleys people found that the rock dust mixed with water and hardened made a perfect building material and so the adobe house was originated.

In Mexico, houses are often built of a fine-grained material called adobe

The hard granite that is a crystalline rock and the much softer sandstone, a stratified or sedimentary rock, are near relations. Sandstone is made principally of the quartz that was broken up when a slab of granite was exposed to the air. The color of sandstone may be very different from granite—it may even be brick red. This is caused by the material which cements the pieces of quartz together. Mud or lime may cement the particles of quartz, and the iron contained in them is often the coloring agent that turns the substance red.

What two building materials are closely related?

Gold and silver are only two of some 1500 kinds of minerals found in the earth. These minerals may be fuels like coal or petroleum; metals like gold and silver; or precious stones like diamond and sapphire. The minerals themselves were caused by heat within the earth, but the forms in which they appear are the result of all the countless changes that they have gone through. Thus diamond and coal may be composed of the same mineral matter but are quite different in appearance because

What is gold and silver?

the mineral went through a different process in formation.

Most of the minerals that become metals are found in the veins of rock. A vein is a crack or crevice of the rock bed. One of the principal ways of filling a rock vein with a mineral deposit is by the work of ground water. This underground water seeps through the earth, washing the minerals from the lighter soils. These minerals are deposited in the cracks and crevices of the layers of rock beneath the surface. Changes caused by heat and pressure and water take place and the mineral deposits become veins of gold, silver, lead, zinc, copper and other materials.

What is coal?

Coal occurs in layers like stratified rock. It is not made up of particles of other rock as sandstone is. It is an *organic* rock, formed from the compressed and changed remains of vegetable life which once grew where the coal bed is.

The great coal beds of the world were formed millions of years ago. The plants that became coal were giant ferns and fern-trees that prob-

ably grew in swamps near the sea. The trunks of trees and vegetable matter were covered with other sediments like sandstone which pressed down upon them. The hidden layer of plants became coal. Coal contains a great deal of

The hidden layers of plants became coal

carbon, and it is this very element that in a different form may become diamond instead of a humble fuel.

Peat is another form of organic sediment. Coal has more carbon in it than peat and is harder. Peat is made almost entirely of the vegetable matter as it grew in the bog.

Coal, like petrified wood, often shows the

shadings and patterns of the plants from which it was made.

What are the different kinds of coal?

Besides the ordinary Bituminous and Anthracite coal, there are many other specialized kinds. *Bituminous* coal is a soft coal, gray-black to velvet-black in color. It burns with a yellow flame. It is the chief coal of the world and there are still enormous quantities of bituminous coal in the world. They will not be exhausted for a thousand or more years to come.

Anthracite coal is a hard coal, iron-black to velvet-black in color. It burns with a pale blue flame and requires a large amount of heat to start burning. There is no smoke or odor in burning so that people are urged to use it in order to keep their city air free from smoke. It is much less common than Bituminous and so it is more expensive. Most households use it while factories are forced to burn soft coals which are not so high priced.

One of the specialized coals is *Cannel coal.* a form of soft coal. It is a dull black in color. *Jet,* a soft coal similar to Cannel coal, has a high

The oil fields are immensely valuable to man

luster and is a more intense black color. The well-known jet beads that you can buy in the stores are made of this variety of coal. Coal is used for the making of gas and coke.

What is petroleum?

The petroleum or oil fields in our country are immensely valuable to man. Petroleum is a mineral oil commonly believed by scientists to be an outgrowth of decayed animal and vegetable material.

How are iron ore-beds formed?

Iron-bearing springs abound throughout the earth. If an iron spring is exposed to the air, a solution of the iron in the water may form under the various changes of temperature and conditions. This usually occurs in a marshy land and the deposits are known as "bog-ore." Iron ore may also form around shallow lakes or at the bottom of peat bogs or in connection with coal formations.

What is chalk?

A chalk cliff is a specialized form of rock, white-colored and made of a substance almost entirely composed of lime. It is a mass of broken skeletons of sea forms and the shells of very tiny sea creatures. Chalk is an organic

rock too, but instead of being made of plant organism it is composed of animals' remains. The chalk cliffs were probably begun thousands of years ago. When sea creatures died, their shells sank slowly to the sea-floor. Again and again throughout the years this deposit of shell and bone substance containing lime was deposited. Finally layers of lime were formed. Perhaps the ancient sea dried up—or the land may have risen, until finally this strange rock, that was made of sea-creatures which had been hardened under the pressure of water and deposits, emerged as a beautiful white cliff.

Where does salt come from?

Nearly all the salt beds in the world are believed to be the remains of ancient salt waters that have dried up. When the water evaporated, the salt was left. These deposits were often very thick so that the salt has to be mined from beneath the ground very much as coal is mined. A large salt mine in the United States lies a fifth of a mile below the surface and air is pumped down hourly to protect the life and health of the workmen. At Stassfurt, Prussia,

there are salt beds 300 to 500 feet thick. A description of a salt mine tells of brilliant lights gleaming against snowy walls, and of workmen's huts carved out of salt like a sugar house in a Grimm's Fairy Tale.

Salt Lake in the United States is said to contain about 400,000,000 tons of common salt. If in some future day the lake should happen to dry up, great white fields of salt would be left. This is exactly what has happened in the past where other lakes have dried to cause the salt beds that exist in various parts of the world today.

What is the greatest mystery of the earth?

The inside of the earth is one of the profound mysteries of the world. It contains the secrets of the past. The rocks that are laid down in layers have imprisoned the remains of life from other worlds and times and a marvelous record of all that is ancient and gone can be uncovered at man's will. Hardened with the rocks or embedded in them, are the skeletons and remains of plants and animals. They are called fossils. Fossils tell us a story of strange creatures that

walked the earth in bygone eras of geologic time.

The inside of the earth is hot and filled with strange brews like a witch's cauldron. Melted

Hot steam may burst forth

rock may rise in streams of fiery liquid and create great damage. Rocks may shift and fall and the earth cracks open. Hot steam may burst forth.

The inside of the earth is a treasure mine.

Gold and silver and precious jewels are hidden there. Coal and iron that we need for comfort and progress and gravel pits and sandstone quarries that yield us building materials—all these are a part of the dark depths that we know so little about.

Chapter IV

THE EFFECT OF THE EARTH ON MAN

Can man change the earth?

WE HAVE seen how the earth is constantly changed through the forces of weather, of pressure, of inward heat, and by the great slow movements that have continued for centuries. Some of these forces man can control. A drainage system may change desert wastelands into property that is fertile enough to be of some use to its inhabitants. Swamplands may be reclaimed. River floods can be held in check. Streams are deepened and widened by the hand of man. Certain things, then, can be done to chain the earth to man's convenience.

But for the most part, man is the helpless slave of the earth and its greater movements. He is powerless against a mountain range. He is unable to drain the waters of a vast ocean.

He cannot check a glacier or a volcano or an earthquake. And so his life is built around the conditions of the place he lives in. He must change with each generation—or perhaps with every year—to meet a changing world.

Why are there more people in the Northern Hemisphere than in the Southern?

Three fourths of all the land surface in the world lies in the northern hemisphere. As man's home is always on the land, this is one reason why the northern hemisphere is more densely inhabited than the southern. Another reason is that the climate of the northern hemisphere is suited to a great number of activities, while the southern hemisphere which has a much more uniform climate offers fewer occupations for its inhabitants.

The northern hemisphere is more closely linked together than the southern. Islands form stepping stones and continents extend over vast areas. This has made it easier for men to spread out, to mingle with one another and to create flourishing cities. The vast stretches of water in the southern hemisphere have made expansion a forbidding thing and the people have kept

to themselves, living an isolated and unprogressive life. Often primitive conditions exist.

How have mountains influenced men?

One of the greatest barriers that men must meet is the mountains of the earth. In the early days of exploration, mountains often changed the history of nationalities. In the story of America alone, we see that the Appalachian mountains stopped the English from invading the western plains of America and the part of the United States today that bears traces of English settlement lies to the east of this mountain range.

The safety of nations often depends upon a mountain barrier at the border-line. Thus the Pyrenees, a massive range unbroken by passes, is a great fortification for France and Spain. The Alps, forming a barrier for several nations, are not as impregnable as the Pyrenees because they are broken by a number of passes and valleys which form passage-ways across.

What are mountain passes?

A mountain pass is a natural opening, leading from one valley to another. It may have been caused by some movement of the earth's crust,

or it may have been cut by a swift stream, a moving glacier, or some combination of harsh weathering forces.

Mountain passes play an important role in the history of mankind. In times of war, they are the weak spots in the great natural fortifications that the mountain range makes. Naturally it is here, then, that generals order their men. Famous mountain passes that have time and again been the strategic points in some great campaign are the Khyber Pass leading from India into Turkestan and Persia, the St. Bernard Pass in the Alps where Napoleon's whole army poured into Italy from France. In the famous French epic, "The Song of Roland," Roland is supposed to meet his death at the pass of Roncesvalles where the Saracens crossed the Pyrenees.

Mountain passes offer a more helpful aid to explorers and pioneers. The South Pass in the Rockies was a gateway to the Pacific in the days of western settlement.

A mountain pass may decide a trade route.

The Mohawk Pass is the grain route from the northwest to the Atlantic seaboard.

What do the mountains offer men?

Offsetting the difficulties of life on a mountain slope, are certain great advantages. The mountains offer men, first of all, protection. After that there are numerous practical gifts that make life richer. The most valuable mineral deposits are often found in mountainous regions. The valleys of mountain ranges are usually fertile lands, easily cultivated. Certain mountain ranges are easily adapted to terracing so that farming is carried on upon the very slopes of the mountains. The grasslands of mountains are natural pasture grounds and the Swiss Alps and other ranges are famous as grazing ground. There are valuable forest preserves in mountainous regions. Lumbering is however a more difficult feat on the highlands and so much of the timber of the mountains has been left untouched.

Mountain streams provide reservoirs of water for water power and irrigation and use in cities near-by.

The grasslands of mountains are natural pasture lands

Far back when the world began and land was shaped by the infall of star dust and by the great movements of the earth, certain flat stretches of land were formed. These were the plains of the earth and were to be in time the principal home of mankind.

What is the importance of of the lowlands?

Life on the plains is the easiest life that the earth offers. Here is an open countryside with no barriers to keep back expansion. Roads lend themselves easily to a smooth flat surface. The soils of plains are usually rich and deep. They are the ideal location for cities because there is room for many people to spread out easily.

There are coastal plains and inland plains, desert plains and the famous *steppes* of Russia. There are flood plains caused by overflowing rivers, glacial plains caused by the deposits or drift of a glacier as it moves over the earth, leaving the material it has dragged with it behind.

What kinds of plains are there?

Valleys have always attracted men to settle in their fertile hollows. Usually a valley contains a river, and nearly all transportation in

How have valleys taken part in human history?

the world follows a waterway. Also the valleys are the highways through plateaus or the bridges between land and sea. An old valley is more suited to agriculture than a young valley because it is wider and usually is characterized by a wide and gentle river rather than a narrow rushing stream of water.

What role does an island play?

Islands have long formed a thrilling background for stories of adventure. "Treasure

Islands have tempted men to explore—to leave the security of the mainland

Island," by Robert Louis Stevenson, is a classic. An island is an interesting settlement to study for it retains its apartness in all forms of its

society and culture as well as geographically. Its inhabitants are independent and highly individual.

Islands off the coast are very often parts of the continent near which they are located. Some natural force separated them. The British Isles were once a part of the continent of Europe it is reasonably supposed. Often a coastal island forms a fine guard, standing between the continent and the open sea as a sort of watchdog.

Islands farther out in the ocean have played an interesting role in human affairs. They have tempted men to explore—to leave the security of the mainland for the uncertain horizons that lie beyond the seas. In ancient times the sturdy Vikings ventured forth, crossing to islands that were like stepping stones to encourage them, the Orkneys, Shetlands, Hebrides, from which they journeyed on to Iceland and even farther to the far continent of America.

The largest city of most of the continents in the world is located on the coast, where it sur-

veys incoming and outgoing trade. New York is the gateway to the vast stretch of territory lying west of the ocean; in South America Buenos Aires holds this strategic position; London opens the door of Europe, Calcutta of Asia, and Sidney of Australia.

Where is the most important city on nearly every continent located?

With the sinking of certain lands came the drowning of valleys as well as highlands. A drowned valley usually formed a bay, and a bay is an advantageous place for a city to grow up around. Bays are easily made into harbors and a harbor is an asset to any locality. The bay of San Francisco is an example and has been called the Golden Gate. Such a bay extends its arms to welcome voyagers and the fortunate city beside the bay is populated with a cosmopolitan inflow from distant parts of the world.

What is the advantage of a drowned coast?

The mantle rock of the earth is just as important to man as the great layers of solid rock that support the world he has built. "Safe upon the solid rock the ugly houses stand"—but if it were not for the top layers

How does the soil direct man's activity?

of soil man could not grow his food that he must have to live. Soil is the most important gift of the earth to man. Whether it is red, brown, or black soil; lumpy, or in dusty grains; the texture of sand or of clay, it becomes the tool of man for his own life-giving nourishment. He learns to water the soil that is dry and to fertilize the soil that is not fertile. He ploughs and he plants and the soil rewards his efforts. Agriculture may be carried on in mountains or plateaus, in plains or in valleys—but one requirement is necessary and that is soil.

How are cities born?

Someone once said that wherever an obstruction occurs, a city is born. Thus at the foot of a mountain there may be a flourishing little village. One of the most important locations of cities is the Fall line. This line is at that point where a stream flowing from old land to a newly formed coastal plain often forms a waterfall. At this waterfall, men had to stop their boats and carry their cargo above the falls and continue their way in smaller boats upstream. Cities developed at these places

where a shifting of cargo was necessary. Philadelphia, Baltimore, Washington, and Richmond are examples.

Great waterfalls which offered tremendous possibilities in the way of water power were the inspiration for flourishing cities like Minneapolis and Niagara Falls.

The great trails of pioneers followed the waterways of the country, and their settlements were nearly always near water. Thus rivers and lakes are always dotted with important cities. Chicago is an example of a lake city that is like a miniature sea port, and New Orleans on the Mississippi and the Gulf is a port of far-reaching influence.

What occupations does the earth offer man?

Farming, grazing, forestry and mining are the chief industries offered by the lands of the earth and fishing is the gift of the seas.

The danger to the forests is that they have been cut down to provide more agricultural lands in the past, and that lumbering has been carried on without thought of the diminishing supply of timber.

A forest conservation movement is doing much to preserve the forests that we have and to encourage the growth of new timberlands.

It is estimated that about a half of the world's population is engaged in agriculture. In the isolated lands extensive farming and cattle-raising on a large scale are carried on, while the fertile lands near large cities are used to grow supplies to meet smaller demands.

Two thousand million tons of mineral resources are produced by the world every year. Coal probably represents about 70 per cent of this total. The whole represents a sum of $9,000,000,000 or so.

What is life dependent upon?

Man cannot live without water, nor can any other growing thing on earth. Besides furnishing a priceless necessity, the waters provide a supply of food that many may not be dependent upon but at least enjoys. Fishing is an industry that is as yet undeveloped to its greatest extent. When the foods of the land become scarce, people will turn to the almost unlimited supplies of the oceans.

How did the ocean become a highway?

Long ago the ocean loomed before the eyes of men as an impregnable barrier. The thinkers of the day, calling upon their imaginations rather than their knowledge, peopled it with horrible sea monsters and had visions of endless seas that offered nothing but peril to courageous voyagers. But the day came when Europe could no longer travel to the Orient to buy spices and silks and teas, for the Turks held the three gateways of the southern and eastern routes. Cut off from her trade with the east, Europe turned toward the Atlantic, wondering if a ship might travel around the world to the westward and eventually come upon India. After these early voyages the terrors of the ocean began to lessen. Men found that storms might blow and waves rise high, but that supernatural animals did not appear and that if the ship was sturdy enough land was finally sighted.

Today transportation on the ocean is a tremendous activity. Commerce has developed so that in the year 1927 the total trade of

exportation and importation carried on by the United States amounted to nearly ten thousand million dollars.

How does the ocean water the soil?

The ocean waters become rain waters. This is one more of the magic changes and transformations that are constantly going on in the world. By means of the heat of the sun, the water in the vast oceans of the earth evaporates. The wind carries this water vapor over the land. When the atmosphere cools, the water vapor becomes rain, dew, snow, sleet, or hail and returns to earth in its new form. By nature's roundabout methods, this same ocean water, that has returned to the earth as rain, may become part of a stream and eventually flow back into the ocean again.

What is the importance of waterways?

In the long history of mankind, the natural waterways of lakes and rivers and the man-made canals have been of tremendous influence commercially. Where there are few railways, trade is dependent upon waterways, and even in advanced countries water travel is cheaper than train transportation.

Some of the great rivers of the world have amazing histories and large cities have grown up along their banks. The Amazon river in Brazil, the Nile in Egypt, the Rhine in Germany, the Mississippi in the United States are rivers connected with ocean traffic that have influenced the destinies and the wealth of great nations of the world.

What are the gifts of the inland waters?

Besides yielding supplies of fish, salt and mineral waters are found in inland waters. Rivers are an aid to the lumbering industry for most of the logs are floated down to the mills from the forests. Water power used for electricity is developed in a stream of any importance. Irrigation methods utilize whatever water is needed where it is at all available, but naturally very arid lands are without neighboring streams, so irrigation cannot always be introduced where it is most needed.

How does climate affect man?

Climate influences the mood of man and the growth of plants, the development of civilization and the great migratory movements of the world. In the northern hemisphere

After these early voyages the terrors of the ocean began to lessen

where the climate is variable, man becomes vigorous and progressive. He may plunge himself into different sorts of occupations. Contrarily in the southern hemisphere he is reduced to an inactive and indolent laziness by the extreme heat and must follow one or another industry throughout a lifetime. Even temporary climatic disturbances will cause migratory movements. The flooding of the Ohio river and Mississippi valleys discourage further settlements there. Just as people will hesitate to live at the foot of a living volcano, they will avoid flood countries.

Why is the United States the fortunate child of the earth?

The United States has risen like a bright star among the nations of the world. The youngest of the great nations, this astonishing country has caught up with the older countries in its commercial and industrial life.

The United States is the child of the world who was born with a silver spoon in its mouth. All the good fairies of the earth showered down gifts so that the young nation started forth under fortunate and blessed circumstances.

The vast area of the country was the first gift. Expansion means development. Where people are packed together, there is the advantage perhaps of intense loyalty to one another, but there is no room to enlarge and to grow. A small country is apt to be stunted materially and economically.

The natural resources of America are unlimited. Whereas France must go elsewhere for her mineral supplies, the United States needs only to turn to a part of her vast area. Whereas Great Britain must import most of her foodstuffs, America can easily grow her own and supply other countries as well.

The United States is able to remain a unified whole in spite of two great mountain ranges which at first seemed to create division lines. Passes and transcontinental railways were developed and utilized in order to maintain the unity that is essential to the health of any nation. Great harbors also serve for shipping interests.

It is fortunate that the United States is a long way from Europe because it has had a

chance to develop and strengthen itself without interference from foreign shores. It is too far away to be molested by the nations on the other side of the ocean.

The climate of the United States is the most favorable possible. Although the country extends over vast areas, it remains in the temperate zone. There are no extremes in temperature such as the northern parts of Canada must suffer or the hot lands below the equator.

Its location is strategically important in relation to the whole world. Its reach as far west as the Pacific brings it into relation with the Far East. And its position on the Atlantic opposite Europe creates the impression that it has much to offer Europe if she will but come across the stretch of water that lies between. And Europe has come across. Her people have sought out the promised land. Her tradesmen have made agreements concerning exports and imports that have been very beneficial to the United States also.

The whole world looks at this big nation,

rich in resources, Gargantuan in size, located by fate and good fortune in the most favored position on the globe. The United States has become a power because of the gifts that the earth gave her.